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The Influence of Visitors on Behaviour and on the Use of Space in Two Species of Ursids: a Management Question?

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Introduction

Zoos and aquariums are making significant contributions to conservation by acting as mentors in socially relevant formal and informal education, thereby influencing people's attitudes and behaviour towards animals and environments. Education is a central role for all zoos and aquariums. This role includes the possession of a defined education policy and the formulation of a strategic development plan. The educational role consists of the interpretation of living collections to attract, inspire and enable people from all types of backgrounds to act positively in terms of conservation. Zoos offer informal (free-choice) education to their visitors and offer formal education by developing links with schools, colleges and universities (WAZA, 2005). In recent years, studies of the influence of the public on animal behaviour have become increasingly relevant. These studies conclude that the visitors can have a positive, neutral or negative effect on the welfare of captive animals (Davey, 2005, 2007; Farrand & Buchanan-Smith, 2005; Fernández et al., 2009; Hediger, 1969; Hosey, 2000, 2008; Kreger & Mench, 1995; Morgan & Tromborg, 2007).

Only two published studies report positive impacts by visitors on animal behaviour. Robson (2004) showed that stereotypies in elephants decreased in the presence of the public. Other studies presented by Glatson (1997), Houts (1999), Choo et al. (2011) and Claxton (2011) focused on visitors involved in enrichment programs. Relatively few studies cite neutral effects of visitors on the behaviour of captive animals. Kalthoff (2002) observed different species of animals in zoos and concluded that visitors did not influence the animals' activity patterns. O'Donovan et al. (1993) also demonstrated that the public did not affect the behaviour of a cheetah female with her cubs. However, most studies of the effect of visitors on the behaviour of captive animals determined that the presence of visitors caused the animals to be stressed.

The greatest number of studies of visitor influence have involved nonhuman primates (see, for example, Guillen-Salazar et al., 2002), but visitor influence has also been studied in other mammals, including felids (Cunningham, 2005), deer (Li et al., 2007), otters (Owen, 2004), and wallabies (Pifarré et al., 2012). Studies of this type have even included birds (Keane & Marples, 2004).

In the family Ursidae, food begging represents the clearest example of the negative influence of visitors on the behaviour of captive animals. This pattern is not considered to be typical in ursids and might endanger the physical and psychological

welfare of these omnivores (Markowitz, 1982; van Keulen-Kromhout, 1976). In this family, the negative effects of the public and the methods through which the animals can become accustomed to visitors over time have been studied in the American black bear by Jordan and Burghardt (1986). Only one study has been published on the effect of visitors on two different types of variables (the use of space and animal behaviour). Conducted on black-tailed prairie dogs, that study showed that if the number of visitors increased, resting increased and vigilance, feeding and locomotion decreased (Eltorai & Sussman, 2010).

The aim of this study was to determine if the influence of visitors on the behaviour and use of space in two species of bears in confinement depended on the characteristics of animal management. The subjects of the study were one pair of giant pandas (*Ailuropoda melanoleuca*) and one pair of brown bears (*Ursus arctos arctos*). All data were collected with the same recording methods and the same sampling techniques. The results of the present study can contribute to a better understanding of environment-behaviour interactions and show the importance of careful management and visitor education programs for the two species of bears.

Keiko and Misha, photos by Ana I. Soriano

Yang Yang and Lun Lun, photos by Carmen Maté

Methods

Subjects and Enclosures

The two brown bears (one male and one female) of this study were housed at the Barcelona Zoo, and the two giant pandas (one male and one female) were housed at Zoo Atlanta.

Table 1. Demographic information on each study subject.

Common name	Name	Sex	Birth date	Birth type	Rearing condition	Arrival date at zoo
European brown bear	Keiko	M	June 1995	Wild-born	Hand	December 18, 1999
European brown bear	Miskha	F	May 2000	Wild-born	Mother	December 28, 2000
Giant panda	Yang Yang	M	September 9, 1997	Captive-born	Mother	November 5, 1999
Giant panda	Lun Lun	F	August 25, 1997	Captive-born	Mother	November 5, 1999

During the observations, the two brown bears were housed individually in two moat-style, semi-naturalised enclosures especially designed for housing bears and constructed of cement. The two enclosures are separated by a wall with entrances to both enclosures. The yards vary in area. The area of the female's yard is 150 m^2, whereas the area of the male's yard is 230 m^2. Each yard has a pool that allows the animals to drink and bathe. The features of each of the enclosures include trees, bushes, several large stones, large overturned logs for climbing and several terraces at different levels with a natural substratum of gravel, sand and bark (Figure 1).

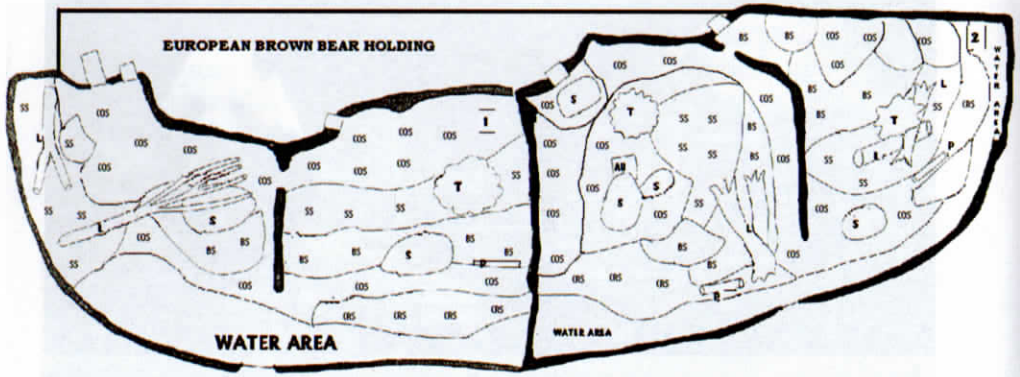


Figure 1. European brown bear holding area. 1= female's enclosure; 2= male's enclosure; S=stones; T=trees; L=logs; BS= bark substrates; CRS= crushed stone substrates; SS= sand substrates; COS= concrete substrates; AU = honey dispenser; P= PVC pipe.

The indoor enclosures are out of sight of the public and consist of cement cages with a drinking trough and a bath (with a total surface area of approximately 10 m^2) (see Soriano *et al.*, 2006 for more details).

The daytime enclosures in which the giant pandas were housed consisted of two areas, one indoors and the other outdoors. The two indoor daytime enclosures had an approximate surface area of 46 m^2 each and had two large front windows that allowed the public to observe the animals. These spaces were equipped with air conditioning and had several long logs placed vertically for climbing, a hammock for resting, a drinking trough and a cork substratum. The two outdoor daytime enclosures consisted of naturalised habitats with an approximate surface area of 495 m^2 each. A deep moat separated the animals from the public. The features of the enclosures included trees, bushes, platforms made of trunks for climbing, a grass substratum and a few shallow pools to serve as drinking troughs (see Figure 2). The indoor areas used at night were out of sight of the public and included cages in which the bears participated in various activities, such as training programs and studies of their cognitive abilities.

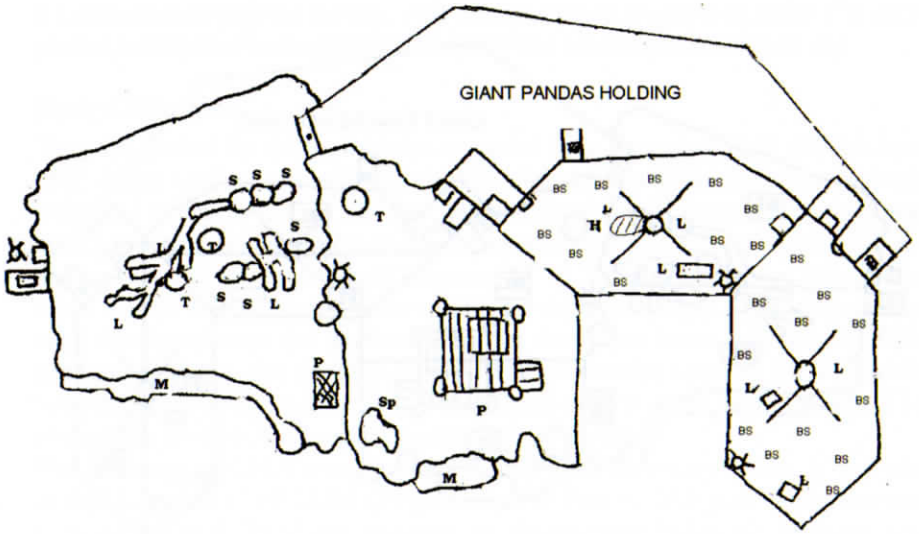


Figure 2. Giant panda holding area. S= stones; T= trees; L= logs; H= hammock; Sp= surface pool; P= platforms; M= moat; BS= bark substrate.

For the purposes of the study, the enclosures were considered to consist of two similar parts defined in terms of the proximity of the subjects to the visitors. The categories of the location variable were defined as *Front Location* if the animals were in the areas close to the visitors and *Back Location* if the animals were in the areas farther from the public (Figure 3 and 4).

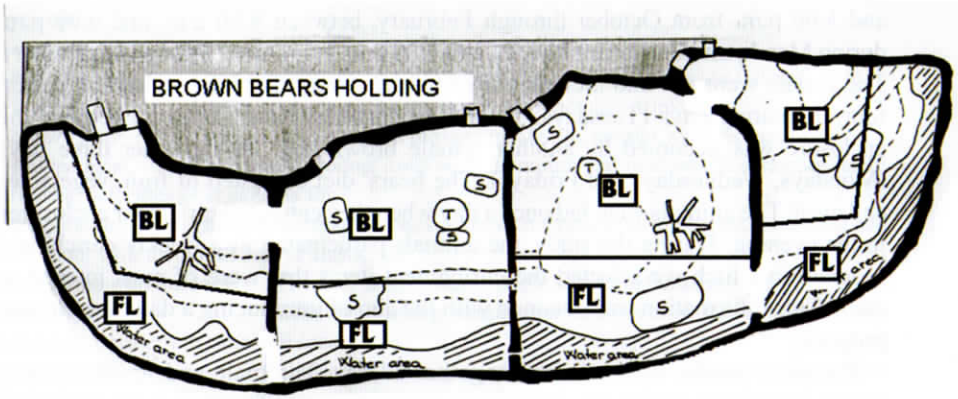


Figure 3. Brown bear holding area, showing the division between the front and back areas. S= stone; T= tree; L= log; BL= back location; FL= front location;---- uneven surface.

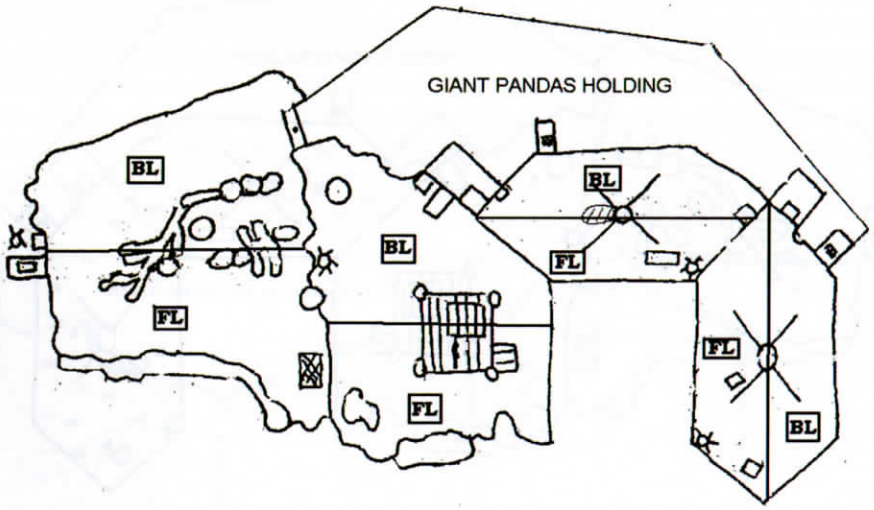


Figure 4. Giant panda holding area, showing the division between the front and back areas. S= stone; T= tree; L= log; BL= back location; FL= front location;---- uneven surface.

Daily Management

The brown bears were housed individually in view of the conditions occurring naturally in the wild. The members of this species are solitary and only interact during the reproductive season. The schedule for the use of the outdoor enclosures by the female and the male depended on the hours of daylight (between 9:00 a.m. and 5:00 p.m. from October through February, between 9:00 a.m. and 6:00 p.m. during March, and between 9:00 a.m. and 7:30 p.m. from April through September). The female went out into the outdoor enclosures every day. The male went out on four alternating days (Tuesdays, Thursdays, Saturdays and Sundays) because the enclosure was occupied by another female brown bear on the other three days (Mondays, Wednesdays and Fridays). The bears' diet consisted of fruit, vegetables and meat. The animals were fed once a day when they entered their indoor enclosures in the evening. During the study, the animals participated in a weekly enrichment program in which we selected the enrichment items that were of most interest to them. This information was obtained with the aim of introducing a daily enrichment program.

The giant pandas were not kept together all day. The male and female usually shared enclosures during the morning and the afternoon. The air-conditioned areas enabled the subjects to be housed under comfortable conditions if the outdoor temperatures were extreme. The giant pandas entered the areas visited by the public between 9:30 a.m. and 4:30 p.m. The animals' diet consisted of biscuits rich in fibre, apples and peanut butter. Biscuits were given to the animals 5 times a day. Bamboo

was provided throughout the day, with a large amount available at night. The giant pandas participated in an enrichment session and a training session each day.

Data Collection

The study period for the brown bears extended from December 2001 through June 2002 during various seasonal periods. The observations of the giant pandas were conducted primarily during October 2002. A focal-animal sampling method was used, and instantaneous samples were also recorded at 2-min intervals during 34 one-hour sessions for each individual (Altmann, 1974). The total number of observation hours was 68 for the brown bears and 68 for the giant pandas. The observations were distributed over the daytime hours for the brown bears and between 9:30 a.m. and 4:30 p.m. for the giant pandas. The observation sessions for the brown bears occurred 48 hr after the day of their once-weekly enrichment program. The observation sessions for the giant pandas were held daily.

The following variables were recorded in this study for each subject: 1) the time of day: (morning (9:00-12:00 a.m.), midday (12:00 a.m.–2:00 p.m.) and afternoon (2:00-4:00 p.m.)); 2) visitor presence or absence (the "visitors" category was assigned if one or more visitors were present in front of the bears' enclosure, whereas "no visitors" was assigned if no visitors were in front of the enclosure); 3) the use of space by the bears in the enclosure (*Front Location* or *Back Location*; and 4) the daily activity pattern (the recorded behavioural categories are shown in Table 2).

Table 2. Definition of the bear behavioural repertoire analysed in this study.

Activity	
Exploration	The animal sniffs the air, the substratum, the food and objects in general.
Vigilance	The animal is in a state of alertness, with its head and ears raised and its eyes open.
Locomotion	The animal moves around the enclosure.
Scent Marking	The bear rubs any part of its body against the features in the enclosure.
Feeding	The animal consumes food; this also includes drinking.
Solitary play	Exaggerated, vigorous movements by the animal, such as jumping.
Maintenance	The animal grooms itself with its mouth and/or claws; it scratches itself, urinates, defecates or shakes its fur.
Manipulation	The bear scratches, bangs, bites or moves physical objects, both food and non-food, with its mouth and/or claws.
Interaction with humans	The bear sits or stands while watching humans.
Stereotypies	Behaviour having no apparent function or objective and showing a repetitive pattern in time and space.
Social interaction	Behavioural traits of an affiliative or agonistic nature between two individuals.
Inactivity	
Stationary	The bear rests sitting or lying down with its muscles relaxed.
Not visible	The bear or its behaviour cannot be seen.

Interactions with humans by the brown bears included various forms of begging, such as begging while sitting or standing, or opening the mouth and moving the head from side to side. In the giant pandas, interactions with humans included significant changes in the frequency of other behaviours. Interactions with humans were observed in the pandas during their medical training sessions and involved the keepers. Stereotypic behaviour in the female brown bear consisted of locomotion in a fixed manner in space and time, whereas stereotypic behaviour in the male brown bear consisted of lateral biting.

Statistics

The statistical test used to evaluate behavioural differences between the brown bears and the giant pandas was based on contingency table analysis. The test calculated Pearson's X^2 and the adjusted residual values (taking an absolute value of 1.96 of the test statistic as a reference based on a normal distribution and a significance level of 0.05) to determine whether the expected frequencies differed from the observed frequencies for the variables studied in the two bear species (Haberman, 1978). The same statistical tests were applied to analyse the effect of the qualitative variables (time of day, daily activity pattern, space use and visitor presence) on the behaviour of each bear species. The uniformity of the use of space was analysed with the spread-of-participation index (Shepherdson et al., 1993; Soriano et al., 2006). A value of 1 indicated minimum use of the facility; a value of 0 indicated that the use of space was totally uniform (Dickens, 1955).

Results

The occurrence (%) of the daily activity patterns at the three times of day was more equally balanced in the giant pandas than in the brown bears. The brown bears showed maximum frequencies of "locomotion" and minimum frequencies of "scent marking", whereas the giant pandas showed maximum frequencies of "stationary" and minimum frequencies of "solitary play". The brown bears, unlike the giant pandas, showed "stereotypies" but not "social interactions". The giant pandas used the space more homogeneously than the brown bears. During data collection, visitor presence was more frequent than visitor absence for both species (Table 3).

In the presence of visitors, the brown bears showed significantly greater frequencies of "stereotypies", "stationary", "locomotion" and "vigilance" ($X^2_{(11)} = 30.50$, $P<0.01$), whereas the giant pandas showed significantly greater frequencies of "exploration", "feeding", "manipulation", "stationary" and "not visible" with visitors present ($X^2_{(11)} = 82.20$, $P<0.01$) (Fig. 5).

In the presence of visitors, the brown bears and the giant pandas used the "back location" more frequently than the "front location" (brown bears: $X^2_{(1)} = 24.15$, $P<0.01$ and giant pandas: $X^2_{(1)} = 7.86$, $P<0.01$). In all cases, the brown bears used the "back location" more frequently (Fig. 6).

The data on the SPI index as a function of visitor presence showed a more homogeneous use of space by the giant pandas (the SPI was 0.13 in the presence of visitors and 0.02 in the absence of visitors) than the brown bears (the SPI was 0.49 in the presence of visitors and 0.69 in the absence of visitors).

Table 3. Occurrence (%) of the daily activity patterns, the use of space and the presence of visitors for each time of day for both species of bears.

	Brown bears			Giant pandas		
	Morning	Midday	Afternoon	Morning	Midday	Afternoon
Activity pattern						
Exploration	5.9	3.5	5.1	2.0	2.2	1.7
Vigilance	7.0	5.0	2.8	1.2	1.2	1.0
Locomotion	13.8	8.8	11.9	1.9	2.3	3.0
Scent Marking	0.1	0.1	0.1	0.1	0.1	0.3
Feeding	1.2	0.8	0.7	4.3	6.3	4.0
Solitary Play	0.4	0.4	0.7	0.1	0.0	0.0
Maintenance	1.0	1.1	0.5	2.9	1.7	1.8
Manipulation	1.3	0.8	0.5	4.3	7.5	7.8
Interaction with humans	0.2	0.1	0.2	0.7	0.2	0.4
Stereotypies	1.4	0.4	3.9	0.0	0.0	0.0
Social Interaction	0.0	0.0	0.0	0.6	0.8	0.7
Stationary	8.0	7.8	3.7	14.0	10.5	11.7
Not visible	0.4	0.5	0.8	1.5	0.6	1.3
Space use						
Front Location	7.3	7.4	7.8	15.2	17.9	12.1
Back Location	33.1	21.7	22.9	18.2	15.4	21.4
Visitor presence						
Visitors	25.7	20.1	22.5	26.3	28.3	24.8
No Visitors	14.7	9.1	8.2	7.1	5.0	8.7

Figure 5. Occurrence (%) of the daily activity patterns for the two bear species in the presence and in the absence of visitors. Statistically significant differences ($P < 0.05$) are indicated by an asterisk.

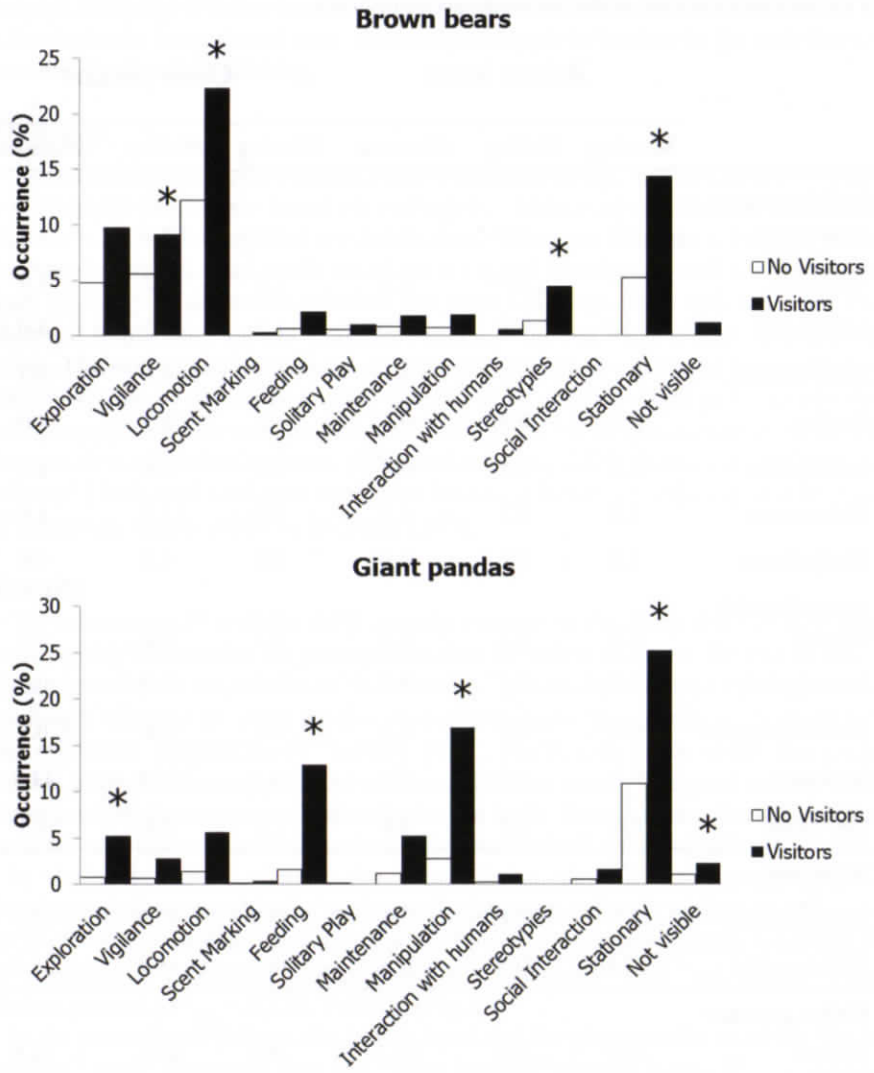
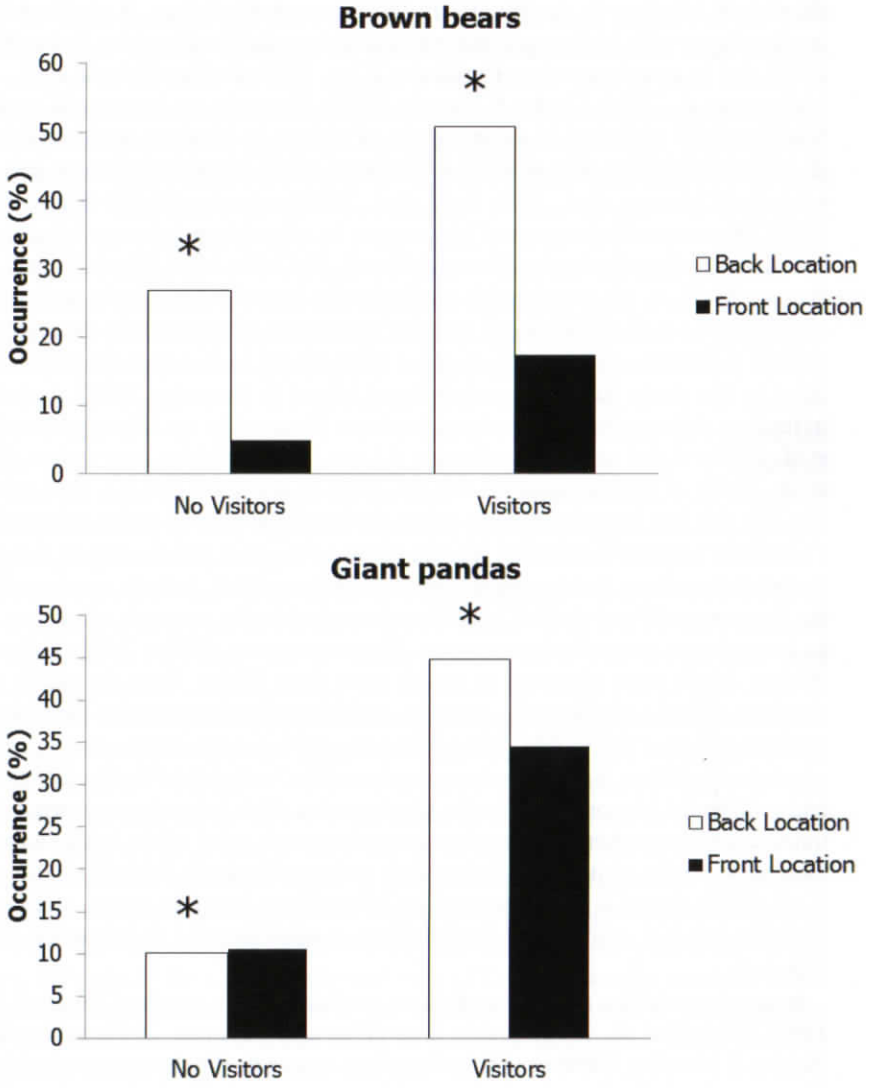


Figure 6. Percentage and statistical significance for each zone as a function of visitor presence for both bear species.



Discussion

In this study, the daily activity pattern and the use of space in relation to visitor presence were used to compare the welfare of two species of bears from two different zoos.

The analysis of the daily activity patterns of the brown bears in this study showed an increase in stereotypies in the presence of visitors. A similar increase in stereotypes with visitors present was found in wallabies (Lockley & Leadbeater, 2005) and in certain species of primates (Cox, 1997; Guillen-Salazar et al., 2002; Mallapur et al., 2005; Carder & Semple, 2008). However, an increase in stationary behaviour was observed in the presence of visitors in Mexican wolves (Pifarré et al., 2012) and prairie dogs (Eltorai & Sussman, 2010) but not in different species of primates (Chamove et al., 1988; Todd et al., 2007) or in cheetah (O' Donovan et al., 1993). Moreover, the presence of visitors can be related to an increase in locomotion in certain species of primates (Hosey & Druck, 1987; Fa, 1989; Mitchell et al., 1992; Hague, 2005), as observed in this study for the brown bears. Cooke and Schillaci (2007) and Li et al. (2007) found a higher percentage of vigilance in the presence of visitors in primates and in a deer species, respectively, as also observed in the brown bears in this study but not in prairie dogs (Eltorai & Sussman, 2010). An increase in feeding in the presence of visitors has been observed in the Diana guenon (Todd et al., 2007), Asian small-clawed otters (Owen, 2004) and Mexican wolves (Pifarré et al., 2012). A similar increase was observed in the giant pandas. However, it is possible that this increase was due not to the provision of food to the animals by the visitors but because the unusual feeding habits of the giant pandas caused the visitors to spend more time looking for the animals in the exhibit. In both species of bears, the frequency of "not visible" behaviour increased in the presence of visitors. Such an increase can occur for two reasons. First, orangutans (Birke, 2002) and gorillas (Kuhar, 2008) were observed to spend more time hidden from the public in the presence of large numbers of visitors to avoid the noise produced by the visitors. In brown bears, the "not visible" behaviour category was only observed to occur in the presence of visitors. Second, the occurrence of the "not visible" behaviour category had a different interpretation in the giant pandas. This behaviour occurred during training sessions, when the animals were at the access gates of the indoor areas with their backs to the visitors and facing their trainers. Cooke & Schialli (2007) and Li et al. (2007) found a higher percentage of vigilance in the presence of visitors in primates and in a deer species, respectively, as also observed in the brown bears in this study.

In previous studies of the use of space, certain primate species (Hosey & Druck 1987; Mitchell et al., 1992), prairie dogs (Eltorai & Sussman, 2010) and cockatoos (Keane & Marples, 2004) used front locations more often in the presence of visitors. These results differ from the findings of the current study for both species of bears. However, cheetah showed greater use of the back location, as did the bears in this study (O' Donovan et al., 1993). The proximity of animals to visitors depends on

multiple factors, including the animal-human bond, the genetic factors affecting the social characteristics of the species, food conditioning associated with visitors and the daily management of the species.

The principal limitation of the study was that the two observation periods were not of the same duration and did not occur during the same periods of the year. Relatively little literature addresses the ethological characteristics of these animals in captivity or in the wild. In both species, it would have been of great interest to study not only the influence of the visitors on the behaviour but also the physiological effect of the visitors on certain hormones that indicate stress (e.g., cortisol). The latter topic has been examined in previous studies of other mammals by Pifarré et al. (2012) and Rajagopal et al. (2011). According to these studies, the number of visitors influences the adrenal activity of individuals in zoos. This effect could have undesirable consequences for *ex situ* conservation efforts in endangered species.

In conclusion, this study's examination of the indicators of the welfare of the giant panda in the presence of visitors produced the following findings: 1) the activity patterns of the giant pandas were relatively more balanced during the day and were more influenced by the daily management schedule (for example, the presentation of food and the training sessions) than by visitors; 2) the giant pandas used the available space in the facility in a much more uniform way and therefore appeared better adapted to the improvements made in their conditions of captivity. It would be interesting to identify similar studies of this topic to allow comparisons of our study with previous results.

All of the findings of this study appear to suggest that the behaviour of the brown bears was more susceptible to the presence of visitors than that of the pandas. A possible reason for this difference is that the management of the brown bears was not adequate. Unlike the giant pandas, the brown bears had not been monitored to ensure their welfare. It can be concluded from this study that the following measures are necessary to improve the welfare of the brown bears: 1) a suitable design for the facility, 2) the establishment of a schedule for a social enrichment programme with the aim of facilitating reproduction, 3) an increase in the number of daily feedings and in the difficulty of access to the food, 4) an increase in the frequency of the enrichment sessions from monthly to weekly, and 5) an educational programme affecting the attitude of visitors towards the animals. To improve animal welfare in captivity, it is necessary to satisfy the physical and psychological needs of the animals. This goal is the responsibility not only of the staff directly involved in the management of the animals but also of the department in charge of educating the public, as enrichment programs can result in failure on days when visitor pressure is significant.

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